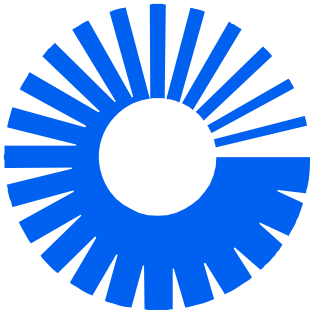


Carrier

A United Technologies Company

HVAC INDUSTRY LANDSCAPE

Richard Lord

Background

- The overall HVAC and the building industry is under extreme pressure from many areas
- For those of you who attended last years CEE meeting we made a presentation on the overall trends in Office buildings
- Since that time things have not slowed and in fact have intensified
- So what I will do today is update you on some of what I have seen in the last year and expect to see going forward for the total HVAC and Building Industry
- I would also cover some issues that directly impact CEE and their guidelines

New Building Industry Influences

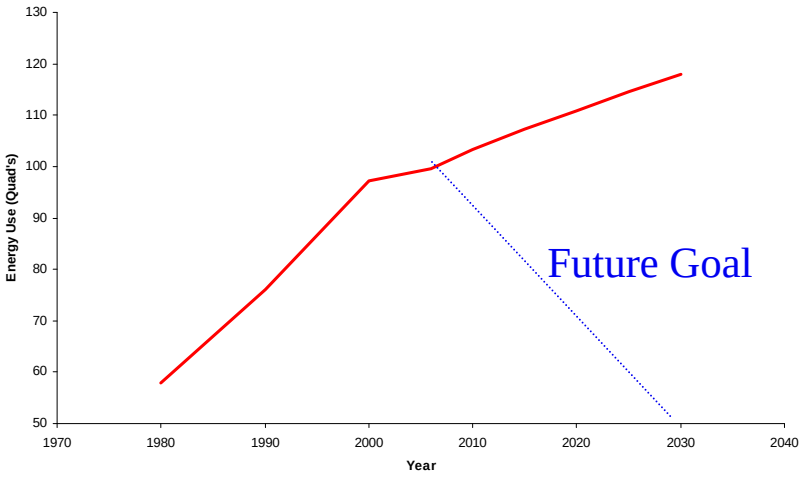
ENERGY EFFICIENCY

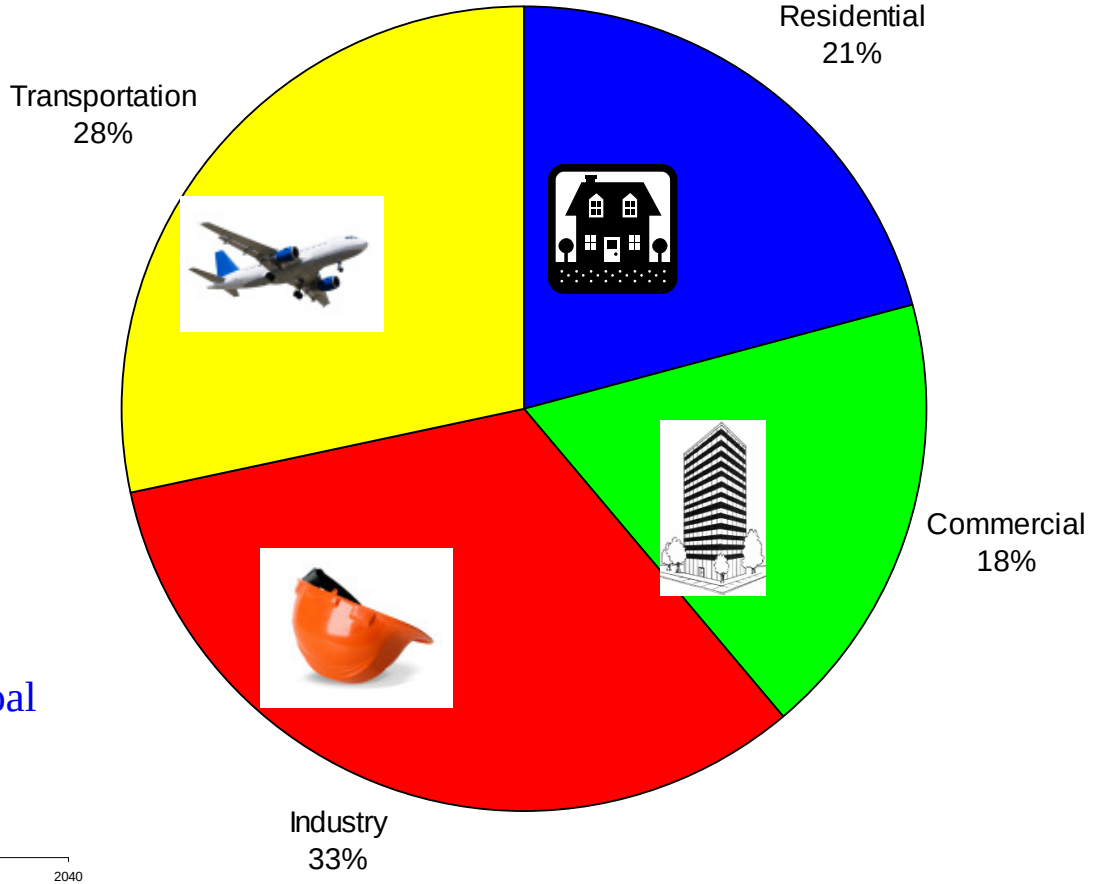
Energy Efficiency is the major issue facing the building industry and HVAC Industry

U.S. Building Energy Consumption

Total Consumption

Year	Quads
1980	57.9
1990	76.1
2000	97.2
2006	99.5
2010	103.3
2015	107.3
2020	110.8
2025	114.5
2030	118.0





Source: 2008 Department of Energy
Buildings Energy Databook

Desire is to be at net zero buildings by 2030

Energy Efficiency Standards

- The typical approach used today for efficiency standards is to define minimum prescriptive component efficiency requirements typically defined at a full load rating point

- There are two main minimum efficiency standards, but there are also state and city standards and they do not always agree

  - ASHRAE 90.1
  - IECC

- There are also many new initiatives for Tier II standards and guidelines that have been accelerated due to the concerns about global warming, energy use and peak demand

There has been significant activity on all of these and most will have major revisions released on 2010

Tier II & III Building Energy Standards

- **Some of the Tier II and III standards and guidelines are;**
  - LEED (just revised) (new version again in 2012)
  - New Building Institute Core Performance Guide
  - EnergyStar Commercial (being revised)
  - FEMP (being revised)
  - CEE
  - ASHRAE 189.1 and ASHRAE 189.2 (new)
  - ASHRAE Building Rating System (new)
  - ASHRAE Advanced Energy Design Guides (new)
  - California Green Building Standards Code (CALGREEN) (new)
  - GBI - Green Building Assessment Protocol for Commercial Buildings (new)
  - IECC - International Green Construction Code (IGCC) (new)

USA Efficiency Challenge

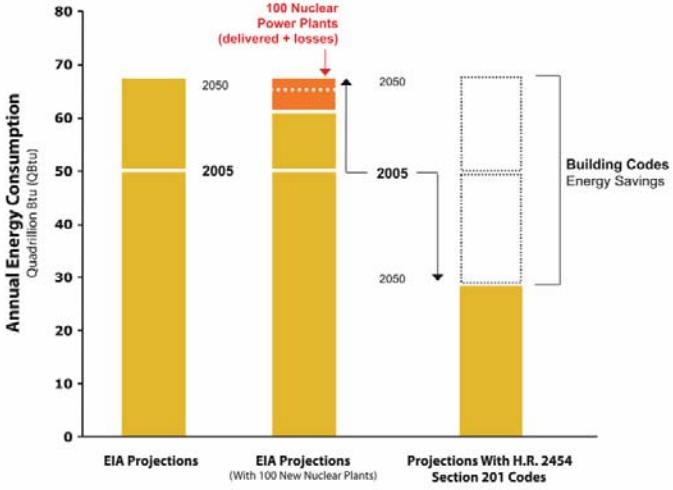
- The draft American Clean Energy and Security Act (H.R. 2454) includes some new challenges for minimum building efficiency standard

- Section 201 requires updating national building energy codes to meet the following energy reduction targets:

  - **in 2010, 30% below the baseline energy code (IECC 2006 and ASHRAE 90.1-2004),**

  - **in 2014-2015, 50% below the baseline energy code, and**

  - **every three years after, out to 2029-2030, an additional 5% reduction.**



U.S. BUILDING SECTOR ENERGY CONSUMPTION PROJECTIONS 2005-2050

Source: ©2009 2030, Inc. / Architecture 2030

Data Source: Energy Consumption and Projections: U.S. Energy Information Administration (EIA); U.S. Department of Energy (DOE). Building Code Energy Reductions Analysis: Architecture 2030.

Assumptions: The Building Sector will consume 78.6% of total U.S. electricity production in 2050 (EIA).

Reality Check on Efficiency Levels

- The current approach for standards is to define the efficiency levels at full load based on a component basis (i.e.. Chiller, rooftop, tower, fan, furnace, etc)
- These levels have increased over the years but we are now approaching the limits of technology
  - Very close approaches and extremely large heat exchangers
  - Significant impact on unit size and cost
  - Components like compressors are at or close to their limits of improvement
  - Negative impact due to the change in refrigerants
- Although we have developed new annualized ratings methods the focus still seems to be based on full load
  - Commercial units seldom if ever run at full load
  - Ambient conditions vary over the load conditions
  - External devices like economizers, energy recover, heat reclaim are not reflected in this approach
- There are new methods for building level rating, but they are only being used on very high performance buildings

Many of the technical experts agree that the only way to meet the future challenges is thru system level efficiencies and whole building energy approaches and annualized efficiency metrics

ASHRAE Standard 90.1

- The ASHRAE standard is an industry developed standard that was developed to prescribe **minimum** requirements for building efficiency.

- It has undergone several revisions, with the first release in 1975 followed by updates in 1980, 1989, 1999, 2001, 2004, and 2007.

- The next schedule release is 2010.

- In 1999 the ASHRAE board approved the ASHRAE 90.1 Standard to be a continuous maintenance standard where addendums were released when approved

- In 2004 they decided to release the addendums at 18 months as a supplement and a new standard every 3 years.

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ASHRAE 90.1 2010 Standard

- There has been significant changes to the standard with 76 addendum changes to date;
  - 20 Addendum fully approved and published in the 2008 Supplement
  - 22 Addendum fully approved and will be published in 2010 release
  - 5 Addendum waiting for Board approval
  - 29 Addendum in the public review process
- The SSPC 90.1 committee meets 4 times per year as a full committee and the subcommittees have conference calls monthly and working groups at least several times per month.
- There is a large backlog of potential ideas, and for example the mechanical committee which handles section 6, and 7, and 10 have 160 ideas on their list
- Typically the changes made to 90.1 are implemented in the IECC

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Approved ASHRAE 90.1 Changes

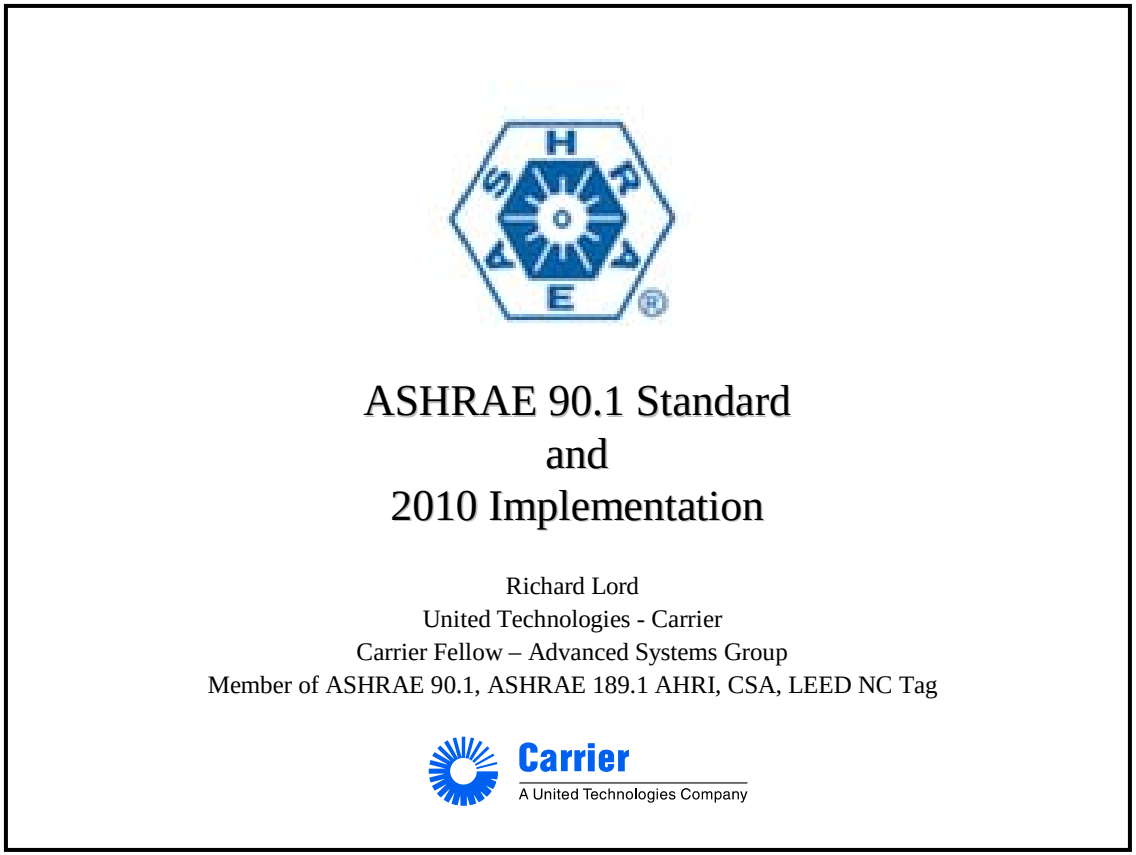
- The following are some of the major changes that have already been approved;
  - Increased envelop insulation requirements
  - New air leakage requirements
  - New and increased cooling tower efficiency requirements
  - Increased packaged unit efficiencies and a new IEER part load metric
  - Several new controls requirements for VAV and other devices
  - New chiller efficiency requirements and alternate path compliance
  - 2 Speed single zone VAV fan control requirements
  - New PTAC efficiency requirements
  - New product classes for heat pump water heaters, pool heaters, SPVAC products, closed cooling towers
  - New pipe insulation requirements
  - Expanded requirements for the use of variable speed controls on pumps, towers, and fans
  - Revised damper leakage requirements

ASHRAE 90.1 Changes (continued)

- Revised tradeoff for economizer elimination
- New requirements for energy recovery
- New requirements for kitchen hoods
- New integral motor HP requirements
- New Transformer requirements
- Computer room HVAC requirements
- Revisions to external lighting and internal lighting power allowances
- New controls requirements for lighting
- Day lighting requirements
- Light test requirements
- Sub-metering requirements
- Revised building modeling requirements

ASHRAE 90.1 Changes

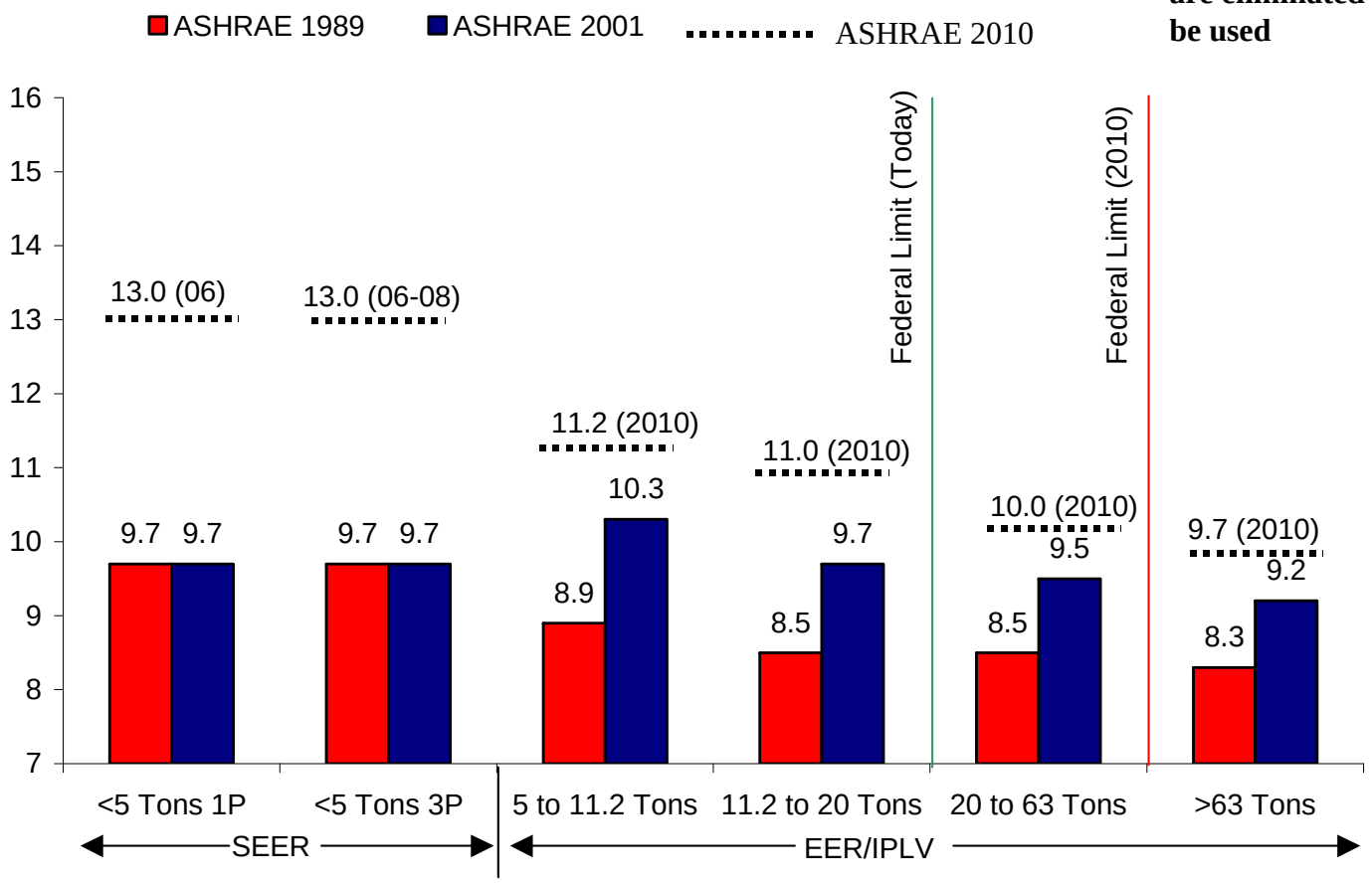
- I have a detailed presentation on all the changes which I can supply to those interested



Section 6 – Addendum g

New Packaged and Split system unit efficiencies

In 2010 the HCFC refrigerants are eliminated and HFC's must be used



There are also new levels for heat pumps

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Section 6 - Addendum y

- This addendum is actually a continuation of addendum g to the 2004 code which increased the efficiencies of packaged equipment
- This addendum completes the change by adding new minimum efficiency requirements for the new AHRI 340/360 IEER part load metric
- The new metric corrects some issues with the old IPLV and better reflects the operation of commercial equipment indoor fans.

New AHRI IEER part load metric

6.2.2 *Integrated Energy Efficiency Ratio (IEER).* For equipment covered by this standard, the IEER shall be calculated using test derived data and the following formula.

$$IEER = (0.020 \cdot A) + (0.617 \cdot B) + (0.238 \cdot C) + (0.125 \cdot D) \quad 1$$

Where:

A	=	EER at 100% net capacity at ARI standard rating conditions	(95 F OAT
B	=	EER at 75% net capacity and reduced ambient (see Table 6)	81.5 F OAT)
C	=	EER at 50% net capacity and reduced ambient (see Table 6)	(68 F OAT)
D	=	EER at 25% net capacity and reduced ambient (see Table 6)	(65 F OAT)

This addendum is published in the 2008 Supplement

2010 Efficiency Requirements

- Table 6.8.1a covers the cooling only products with either electric heat or gas heat
- Similar changes have been made to 6.8.1b for heat pumps
- This now includes the minimum values for IEER
- There is one more addendum that will be submitted to change the condensing units to IEER for >135K units.

Table 6.8.1A Electrically Operated Unitary Air Conditioners and Condensing Units –Minimum Efficiency Requirements

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency[a]	Test Procedure[b]
Air Conditioners, air cooled	<65,000 Btu/h[c]	All	Split System	13.0 SEER	ARI 210/240
			Single Package	13.0 SEER	
Through-the-wall air cooled	≤30,000 Btu/h[c]	All	Split System	12.0 SEER	
			Single Package	12.0 SEER	
Small-duct high velocity, air cooled	<65,000 Btu/h[c]	All	Split System	10.0 SEER	
Air Conditioners, Air Cooled	≥65,000 Btu/h and <135,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.2 EER 1.4 IEER	ARI 340/360
		All other	Split System and Single Package	11.0 EER 11.2 IEER	
	≥135,000 Btu/h and <240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.0 EER 11.2 IEER	
		All other	Split System and Single Package	10.8 EER 11.0 IEER	
	≥240,000 Btu/h and <760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	10.0 EER 10.1 IEER	
		All other	Split System and Single Package	9.8 EER 9.9 IEER	
	≥760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	9.7 EER 9.8 IEER	
		All other	Split System and Single Package	9.5 EER 9.6 IEER	
Air Conditioners, Water and Evaporatively Cooled	< 65,000 Btu/h	All	Split System and Single Package	12.1 EER 12.3 IEER	ARI 210/240
	≥65,000 Btu/h and <135,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.5 EER 11.7 IEER	ARI 340/360
		All other	Split System and Single Package	11.3 EER 11.5 IEER	
	≥135,000 Btu/h and <240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.0 EER 11.2 IEER	
		All other	Split System and Single Package	10.8 EER 11.0 IEER	
	≥240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.0 EER 11.1 IEER	
		All other	Split System and Single Package	10.8 EER 10.9 IEER	
Condensing units, air cooled	≥135,000 Btu/hr			10.1 EER 11.2 IPLV	ARI 365
Condensing units, water or evaporatively cooled	≥135,000 Btu/hr			13.1 EER 13.1 IPLV	

[a] IPLVs and part-load rating conditions are only applicable to equipment with capacity modulation.
[b] Section 12 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.
[c] Single-phase, air-cooled air conditioners <65,000 Btu/h are regulated by NAECA. SEER values are those set by NAECA.

IEER Change

- The IEER was developed by the AHRI 340/360 committee to fix problems with the current IPLV
  - Did not accurately reflect the continuous operation of the indoor fan
  - Was only based on an 80 F ambient
  - Did not encourage improvements at part load operation
  - Did not accurately model multiple stages and variable capacity machines
  - Did not model VAV systems correctly
- The IPLV will be retired on 1/1/2010 and AHRI and ASHRAE 90.1 will adopt the IEER

CEE needs to update their requirements to reflect IEER

Tier II & III Efficiency Requirements

- We have a problem in the industry right now with the Tier II and III efficiency requirements between ASHRAE 189.1, EnergyStar and CEE where they do not agree and are not harmonized
  - **CEE**
    - Change the category classifications from Tier III to Tier II and Tier II to Tier I which does not align with common practices in the industry
    - Implemented the 0.2 credit for gas heat backwards from the ASHRAE methodology
    - Has not released IEER requirements and is still using IPLV which will not be certified after 1/1/2010
  - **ASHRAE 189.1**
    - Includes higher level efficiencies but they are different than CEE.
    - The standard includes full load EER's and IEER's
  - **EnergyStar**
    - Was going to drop the program, but now is in the process of trying to develop new metrics as their current standard will be less than the minimum 2010 ASHRAE 90.1 levels

- This is making it difficult for the HVAC industry to complete the 2010 product plans with the new refrigerants as the Tier II and Tier III efficiencies are not clear

Tier II and III Industry Requirements

PACKAGED ROOFTOP EFFICIENCY REQUIREMENTS

Cooling on Units

				TIER I		TIER II				TIER III
Equipment Type	Size Category	Heating Category	Subcategory	ASHRAE 2007	ASHRAE 2010	CURRENT CEE TIER 1	ENERGYSTAR 1/1/2010	ENERGYSTAR 1/1/2012	ASHRAE 189.1	CURRENT CEE TIER 2
Air Conditioner	<65K	Electric	Split System	13.0 SEER	13.0 SEER	14.0 SEER 12.2 EER	14.0 SEER 12.0 EER	14.5 SEER 12.0 EER	14.0 SEER 12.0 EER	15.0 SEER 12.7 EER
			Single Package	13.0 SEER	13.0 SEER	14.0 SEER 11.8 EER	14.0 SEER 11.0 EER	TBD	14.0 SEER 11.6 EER	15.0 SEER 12.2 EER
		Gas Heat	Split System	13.0 SEER	13.0 SEER	14.0 SEER 12.0 EER	14.0 SEER 12.0 EER	14.5 SEER 12.0 EER	14.0 SEER 12.0 EER	15.0 SEER 12.5 EER
			Single Package	13.0 SEER	13.0 SEER	14.0 SEER 11.6 EER	14.0 SEER 11.0 EER	TBD	14.0 SEER 11.6 EER	15.0 SEER 12.0 EER
	>=65K & <135K	Electric	All	10.3 EER	11.2 EER 11.4 IEER	11.7 EER 11.9 IPLV	11.5 EER 11.6 IEER	TBD	11.5 EER 12.0 IEER	12.2 EER 12.4 IPLV
		Gas Heat	All	10.1 EER	11.0 EER 11.2 IEER	11.5 EER 11.9 IPLV	11.5 EER 11.6 IEER	TBD	11.3 EER 11.8 IEER	12.0 EER 12.4 IPLV
	>=135K & <240K	Electric	All	9.7 EER	11.0 EER 11.2 IEER	11.7 EER 11.9 IPLV	11.7 EER 11.8 IEER	TBD	11.5 EER 12.0 IEER	12.2 EER 12.4 IPLV
		Gas Heat	All	9.5 EER	10.8 EER 11.0 IEER	11.5 EER 11.9 IPLV	11.7 EER 11.8 IEER	TBD	11.3 EER 11.8 IEER	12.0 EER 12.4 IPLV
	>=240K & <760K	Electric	All	9.5 EER 9.7 IPLV	10.0 EER 10.1 IEER	10.7 EER 10.9 IPLV	NA	NA	10. EER 10.5 IEER	11.0 EER 12.0 IPLV
		Gas Heat	All	9.3 EER 9.5 IPLV	9.8 EER 9.9 IEER	10.5 EER 10.9 IPLV	NA	NA	9.8 EER 10.3 IEER	10.8 EER 12.0 IPLV
	>=760K	Electric	All	9.2 EER 9.4 IPLV	9.7 EER 9.8 IEER	9.9 EER 11.0 IPLV	NA	NA	9.7 EER 10.2 IEER	10.4 EER 11.0 IPLV
		Gas Heat	All	9.0 EER 9.2 IPLV	9.5 EER 9.6 IEER	9.7 EER 11.0 IPLV	NA	NA	9.5 EER 10.0 IEER	10.2 EER 11.0 IPLV

Potential Future ASHRAE 90.1 Changes

- DOAS Equipment Requirements
- VRF Equipment Requirements
- Heat Pump Chillers Requirements
- Solar Water Heating and Solar heating requirements
- Improved Heat Pump water heaters
- Expanded heat recovery
- Increased Duct insulation
- Radiant technology
- Air and Water Economizer refinements
- Additional products recognized
- Acceptance testing
- System level efficiencies
- Whole building efficiencies

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Potential Future ASHRAE 90.1 Changes

- Small motor efficiencies
- Large chiller plant requirements
- Default modeling equations for appendix G
- Industry Requirements
- Plug load requirements
- Expanded computer room requirements
- Additional controls requirements
- Variable flow chiller
- Tower approach requirements
- Duct leakage requirements
- Refrigeration system requirements
- Duct pressure drop requirements
- Re-commissioning

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Sample Acceptance Test – ASHRAE 90.1

The following is an example of an ASHRAE 90.1 proposal for economizer

Proposed Requirement

6.7.2.5 HVAC System Acceptance. The following equipment and systems shall be certified as meeting the Acceptance Requirements for Code Compliance. A Certificate of Acceptance shall be submitted to the building department that certifies that the equipment and systems meet the acceptance requirements:

(a) Air economizers shall be tested in accordance with Normative Appendix TBD

EXCEPTION: Air economizers installed by the HVAC system manufacturer and certified as being factory calibrated and tested are not required to be field tested.

Other Possible Tests:

(b) Outdoor air ventilation systems? (measured OA within 10% for any supply flow)

(c) Package unit controls? (no simultaneous heat/cool, min OA damper position, scheduling, etc.)

(d) Demand control ventilation?? (min OA varies based on CO_2)

(e) Supply fan variable flow controls? (supply fan modulates based on zone demand)

(f) Hydronic system variable flow controls? (no valve leakage, pump modulates based on zone demand)

(g) Boiler or chillers that require isolation controls? (no valve leakage)

(h) Hydronic systems with supply water temperature reset controls? (setpoint resets)

Sample Acceptance Test – ASHRAE 90.1

Normative Appendix: Construction Inspection

- Prior to Functional Testing, verify and document the following:
  - Economizer high-limit shutoff control setpoint complies with Tables 6.5.1.1.3A and 6.5.1.1.3A.
  - Economizer lockout control sensor is located to prevent false readings.
  - System is designed to provide up to 100% outside air without over-pressurizing the building.
  - For systems with DDC controls lockout sensor(s) are either factory calibrated or field calibrated.
  - For systems with non-DDC controls, manufacturer's startup and testing procedures have been applied

Sample Acceptance Test – ASHRAE 90.1

Normative Appendix: Functional Testing

Step 1: Disable demand control ventilation systems (if applicable)

Step 2: Enable the economizer and simulate a cooling demand large enough to drive the economizer fully open. Verify and document the following:

- Economizer damper is 100% open and return air damper is 100% closed.
- For systems that meet the criteria of 6.5.1, verify that the economizer remains 100% open when the cooling demand can no longer be met by the economizer alone.
- All applicable fans and dampers operate as intended to maintain building pressure.
- The unit heating is disabled

Step 3: Disable the economizer and simulate a cooling demand. Verify and document the following:

- Economizer damper closes to its minimum position.
- All applicable fans and dampers operate as intended to maintain building pressure.
- The unit heating is disabled

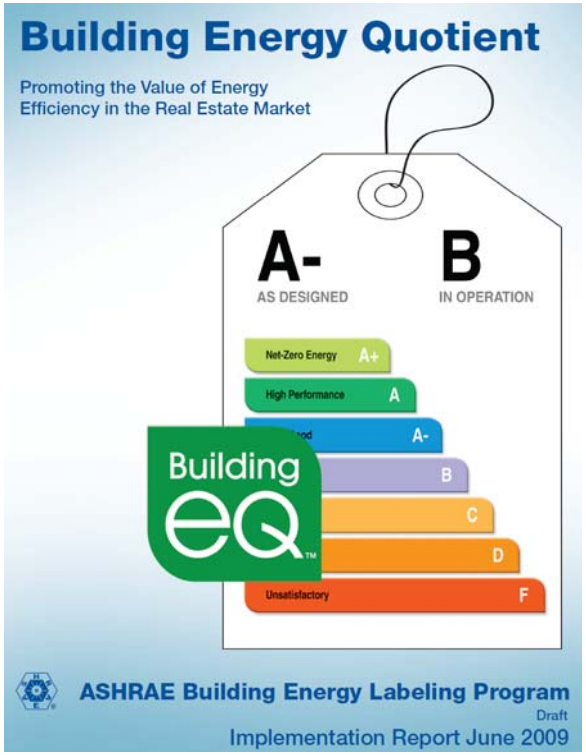
Step 4: Simulate a heating demand and set the economizer so that it is capable of operating (i.e. actual outdoor air conditions are below lockout setpoint). Verify the following:

- The economizer is at minimum position

Step 5: Restore demand control ventilation systems (if applicable) and remove all system overrides initiated during the test.

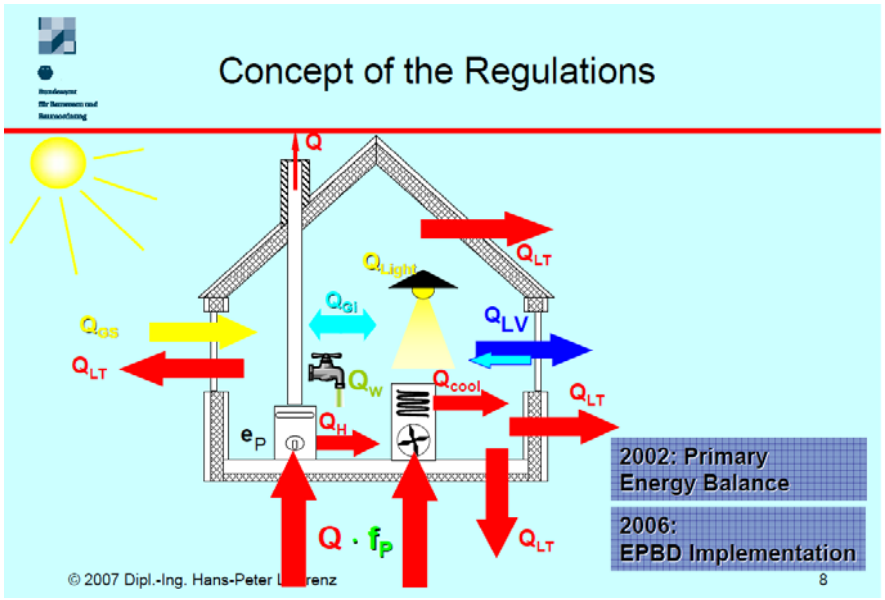
ASHRAE Whole Building Metric

- At the June 2009 ASHRAE meeting they introduced the new Building Metric
- A building energy labeling program provides the general public, building owners and tenants, potential owners and tenants, and building operations and maintenance staff with information on the potential and actual (measured) energy use of buildings. This information is useful for a variety of reasons:
  - Building owners and operators can see how their building compares to peer group buildings, as measured against the highest performing buildings, to establish a measure of their potential for energy performance improvement.
  - Building owners can use their energy rating differentiate their building from others to secure potential buyers or tenants.
  - Potential buyers or tenants can gain insight into the value and potential long-term cost of a building.
  - Operations and maintenance staff can use the results to inform their decisions on maintenance activities and influence building owners and managers to pursue energy efficiency upgrades and demonstrate the return on investment for these projects.

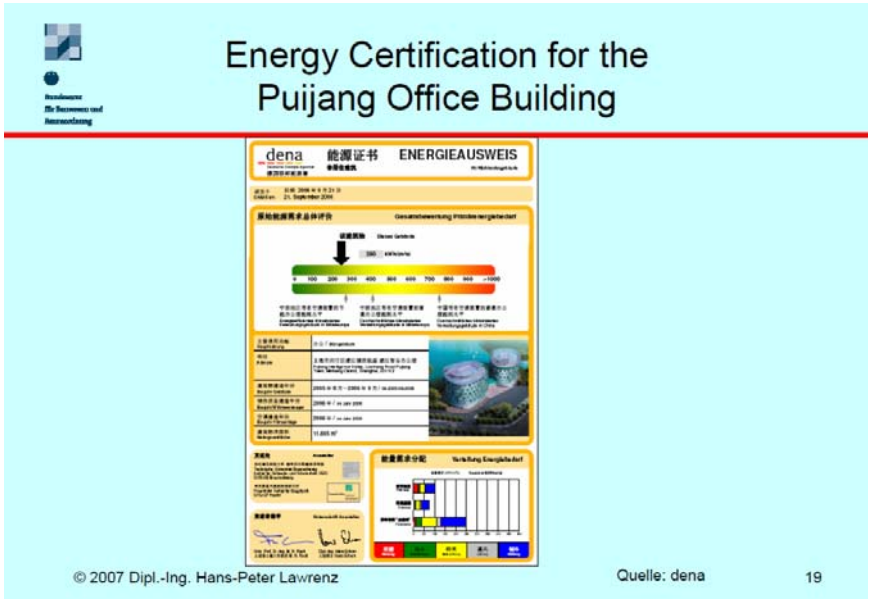


European Building Metrics

- Europe also has a similar initiative to the ASHRAE building metrics and has started to develop rating standards as well as a building block approach to develop and estimate the building energy



- It is also being considered for use in China



ASHRAE 189.1 Standard

- ASHRAE has been in the process of developing a green building standard to supplement ASHRAE 90.1
- The standard has been thru 3 public reviews and has not been released for a 4th public review of changes that have been made to the 3rd public review based on comments
- The standard goes beyond ASHRAE 90.1 and includes
  - Higher prescriptive requirements
  - Water use requirements
  - Indoor air quality requirements
  - Renewable energy requirements
  - Transportation plans
  - Monitoring
  - Site selection requirements

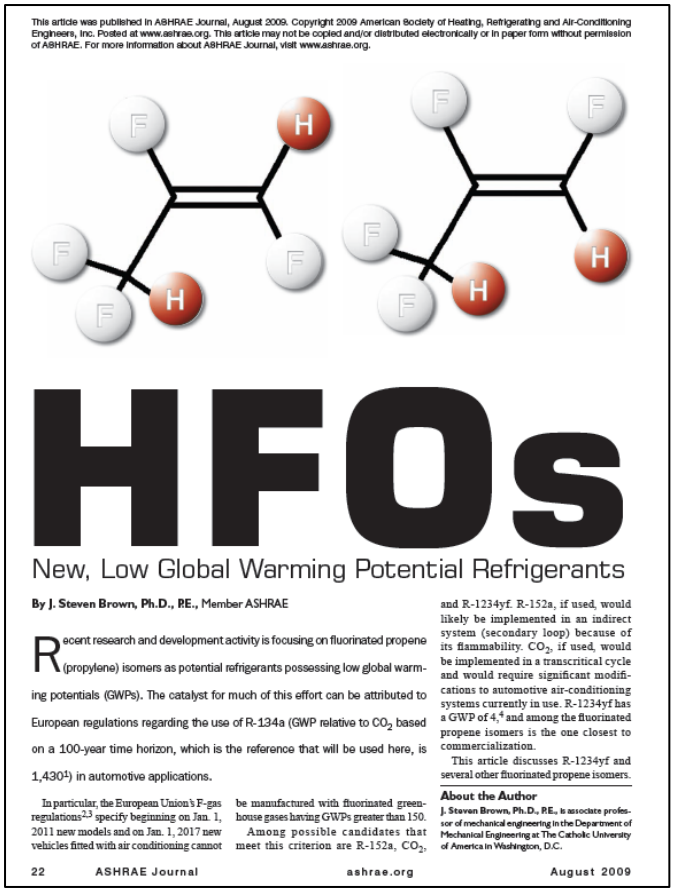
REFRIGERANT ISSUE

Existing Refrigerant Issue

- As you probably know the HVAC industry is close to completing a huge task of redesign almost every product to eliminate the use of refrigerant HCFC-22
- Essential almost every product has been redesigned.
- At the same time many of the products had to be upgraded for a significant minimum efficiency requirement change and this was on top of a loss in efficiency due to the change from R22 to R410a.
- The driver behind this was to reduce the use of refrigerants that have a ozone depletion potential greater than zero.
- This was on top of the slow down in the economy which has really challenged the industry

New Refrigerant Issue

- But just as we are completing the HCFC to HFC transitions legislation is in development to begin the phase out of HFC refrigerants with high Global Warming Potential
- This initiative started in Europe with the auto industry which is know to have a high leakage rate.
- In Europe they have passed the F Gas regulations to phase on the use of HFC-134a in new model automobiles in 2011 but it will likely get delayed 1 or 3 years
- The auto industry is focused on CO_2 as a refrigerant or the new HFO refrigerant 1234yf
- Both these refrigerants have issues
  - CO_2 although a natural refrigerant it requires a transcritical cycle, has a lower efficiency and very high working pressures
  - 1234yf is a new refrigerant mixture that has a GWP of 4 but is semi-flammable and will likely be expensive



HFOs

New, Low Global Warming Potential Refrigerants

By J. Steven Brown, Ph.D., PE., Member ASHRAE

Recent research and development activity is focusing on fluorinated propene (propylene) isomers as potential refrigerants possessing low global warming potentials (GWPs). The catalyst for much of this effort can be attributed to European regulations regarding the use of R-134a (GWP relative to CO_2 based on a 100-year time horizon, which is the reference that will be used here, is 1,430[1]) in automotive applications.

In particular, the European Union's F-gas regulations[2,3] specify beginning on Jan. 1, 2011 new models and on Jan. 1, 2017 new vehicles fitted with air conditioning cannot be manufactured with fluorinated greenhouse gases having GWPs greater than 150.

Among possible candidates that meet this criterion are R-152a, CO_2, and R-1234yf. R-152a, if used, would likely be implemented in an indirect system (secondary loop) because of its flammability. CO_2, if used, would be implemented in a transcritical cycle and would require significant modifications to automotive air-conditioning systems currently in use. R-1234yf has a GWP of 4,[4] and among the fluorinated propene isomers is the one closest to commercialization.

This article discusses R-1234yf and several other fluorinated propene isomers.

About the Author

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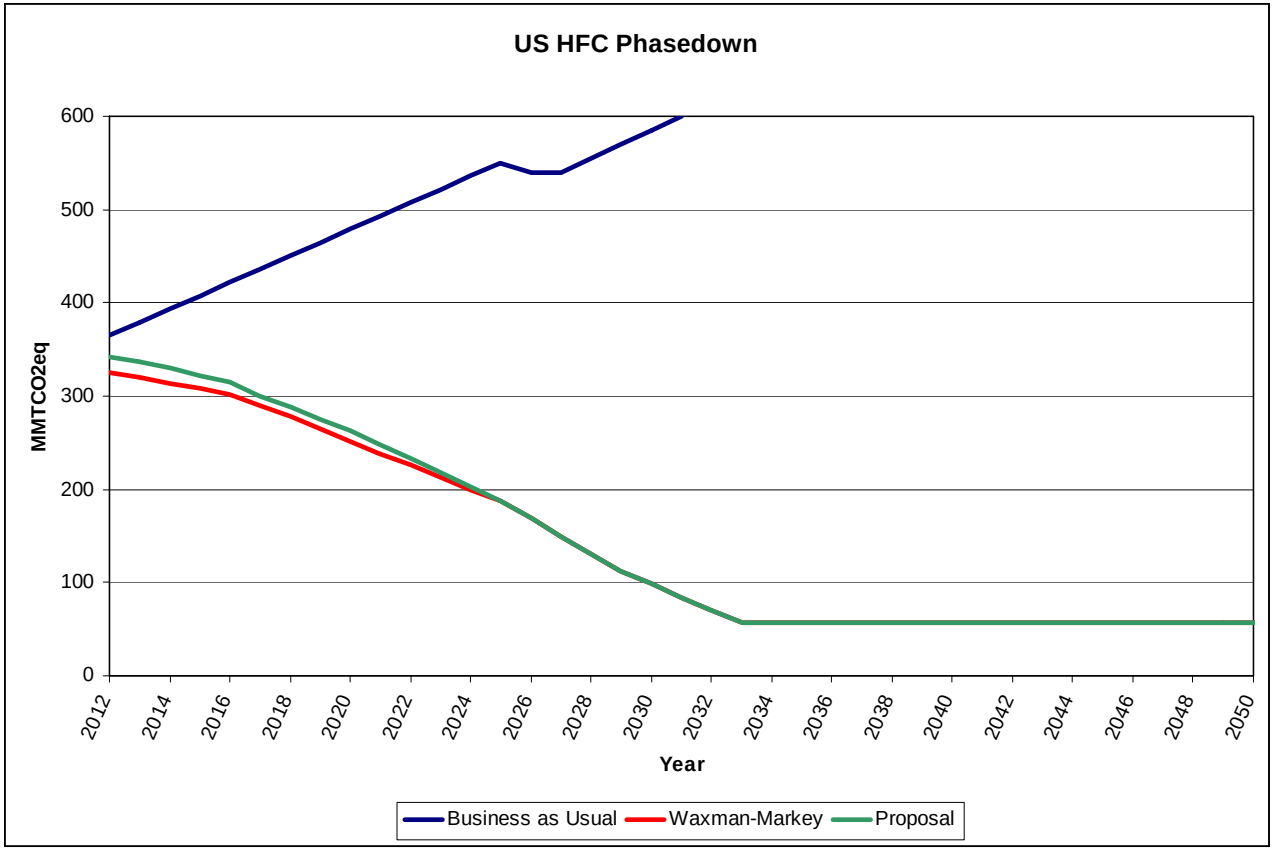
22 ASHRAE Journal ashrae.org August 2009

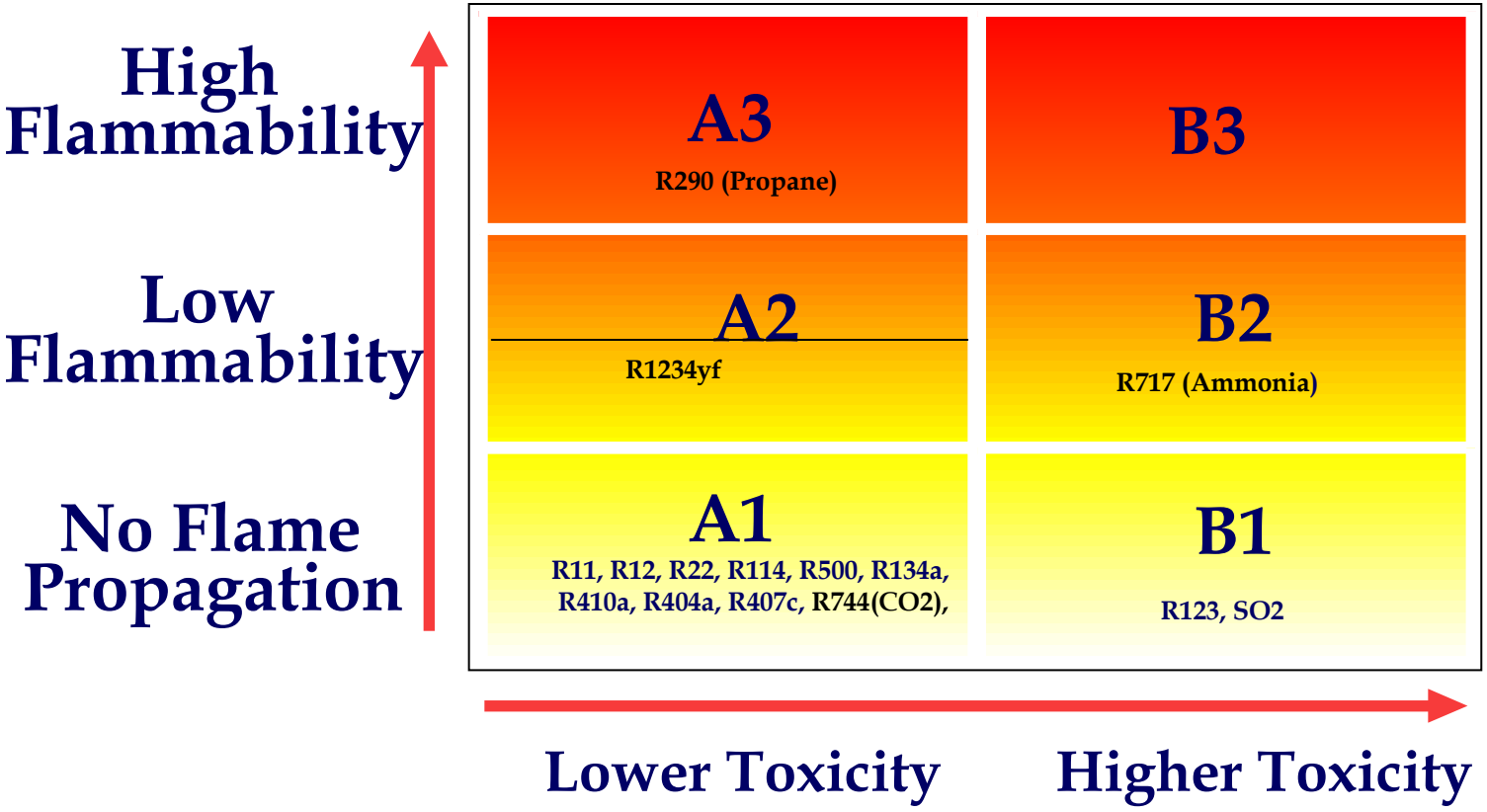
US HCFC Legislation

- As many of you may be aware there has been considerable discussion and language is include in the draft American Clean Energy and Security Act (H.R. 2454).
- JA few weeks ago the USA, Canada and Mexico released a proposal to the upcoming Montreal Protocol meeting to be held in November to phase out HCFC to refrigerants with a GWP below 150



Refrigerant Classifications

ASHRAE 15 SAFETY RATINGS



Other Refrigerant Issues

- We are also see a focus on refrigerant management;
  - Optimal charge management – Electronic Charge devices
  - Reduction in leak rates – Mandatory Leak Checking
  - Monitoring and measure field leak rates – ASHRAE 196
  - Overall Refrigerant charge reductions
  - Re-cycling of refrigerants
  - Upgrade of older refrigerant systems
  - New refrigerant service practices

NEW TECHNOLOGY TRENDS

New Technology Trends

- Increased use of dedicated outdoor air systems
- Hybrid systems with combinations of subsystems
  - Integrated Energy Recover
  - Evaporative pre cooling and evaporative condensers
- New Systems
  - Chilled beams
  - Radiant cooling and heating
  - Secondary heat pump systems
  - Heat Reclaim
  - Water source heat pumps
  - Free cooling
  - Desiccant dehumidification
  - Variable speed indoor fans
  - Variable speed compressor and increased stages of capacity
  - Variable latent systems
  - New system level control systems
  - Fully integrated system level controls
  - System level monitoring

Recommendations for CEE

- Need to address the issues with the Tier I and II packaged unit efficiencies
  - Update the requirements for part load to use the IEER
  - Correct the issues with the 0.2 credit
  - Correct the issues with the heat pump ratings
  - Confusion with the naming of the Tiers

- Need to look at alternate methods for future efficiency requirements including hybrid systems (i.e. Guideline V)

- Begin to consider how to address system level efficiencies and the building rating system

- When developing new requirements try not to define the solution and instead define the desired end state (i.e.. Don't define the type of design details for an economizer when the real requirement is economizer reliability)

QUESTIONS AND DISCUSSION